A Mode of Unifying Gravitation and Strong Interactions Proposed by the Model of Expansive Nondecelerative Universe

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Abstract

The model of Expansive Nondecelerative Universe exploiting the Vaidya metrics is used as a tool for unification of gravitation and strong interactions. The proposed approach stems from the capability to localize the energy of gravitational field and enables to reach a certain level in unifying the general theory of relativity and quantum chromodynamics. A relationship between the energy binding quarks and gravitational energy of virtual black holes is rationalized.

In the model of Expansive Decelerative Universe (ENU) continuous matter and gravitational field creations occur simultaneously. Due to the negative value of the latter, the total energy of the Universe is exactly of zero value [1]. Such a Universe can expand without limitation by the velocity of light [2, 3]. Based on the total zero energy value it can be postulated that also the total charge, linear momentum and angular momentum of the Universe are of zero value. This is why the gravitation is understood only as one of the forms of the matter creation which can manifest itself in cases when the density of gravitational energy of any body exceeds the critical gravitational energy density. Further, we suppose that energies of all the fundamental physical interactions must be compensated by the negative energy of gravitational field. This is a key point allowing to propose a mode of unification of the fundamental physical interactions.

In our previous paper [3] it was evidenced that within the first approximation the Tolman's relation in ENU reads as follows

$$\epsilon_g = -\frac{R.c^4}{8\pi.G} = -\frac{3m.c^2}{4\pi.a.r^2} \qquad (1)$$

where ε_g is the density of the gravitational energy emitted by a body with the mass m at the distance r, R denotes the scalar curvature (contrary to a more frequently used Schwarzschild metrics, in the Vaidya metrics $R \neq 0$ [4] also outside the body).

For the energy binding quarks it holds that the higher distance between them, the higher energy of their binding (the energy approaches the zero value in a limiting case of zero distance). This fact can be expressed by relation

$$E_b = \frac{\hbar.c}{a}.\frac{r^2}{l_{Pc}^2} \qquad (2)$$

in which E_b is the binding energy of a quarks couple, r is their distance, $\hbar.c/a$ represents the minimum possible energy, i.e. the energy of a photon of the wavelength a, l_{Pc} is the Planck distance defined as

$$l_{Pc} = \left(\frac{G.\hbar}{c^3}\right)^{1/2} \approx 10^{-35}m \qquad (3)$$

and a is the gauge factor that at present

$$a \approx 10^{26}m \qquad (4)$$

In some theoretical concepts a linear relationship between the binding energy and the distance is introduced, it should be pointed out that the validity of relation (2) postulated by us in [5] was theoretically proved in an independent

way [6].

As follows from (2) there are two limiting values of binding energy. In cases when $r = l_{Pc}$, the binding energy is of the minimum value and contrary, when $r = a$, this energy is equal to $M_u.c^2$[5] which represents the maximum possible value (M_u is the mass of the Universe). In actual cases $r \simeq 10^{-15}$m (the range of nuclear forces), the binding energy of quarks approximates $E_b \simeq 10^{-11}$ J. This value is in excellent agreement with the kinetic energy of π^+ mesons (200 MeV) determined by their scattering on protons accompanied by subsequent resonance creation.

When attempting to unify the general theory of relativity and quantum chromodynamics one must realize the disproportion between a comparatively small mass of the quarks and substantial energy binding them together. Based on the generally accepted concept of virtual black holes we supposed that the energy binding two quarks being in the distance r is equal to the energy of the gravitational field of a virtual black hole of diameter r. The largest is the black hole, the largest is its gravitational energy which, in turn, is identical to the binding energy between two quarks. This phenomenon can be described by the term asymptotic freedom.

For the binding energy it must then hold

$$E_b = |E_g| = \left|\int \epsilon_g dV\right| \qquad (5)$$

where ϵ_g is the energy density of a virtual black hole and E_g is the energy of its gravitational field. It follows from (1) and (5) that

$$E_b = \frac{m_{bh}.c^2.r}{a} \qquad (6)$$

where m_{bh} is the black hole mass, r is its gravitational diameter representing at the same time the distance between two quarks. The mass of black hole can be calculated as

$$m_{bh} = \frac{r.c^2}{2G} \qquad (7)$$

and substitution (6) into (7) leads finally to

$$E_b = \frac{c^4.r^2}{2G.a} \qquad (8)$$

Multiplying both the denominator and numerator by $\hbar$ we get relation (2) evidencing the unification of the general theory of relativity and quantum chromodynamics.

For the effective gravitational range $r_{ef(g)}$ of a particle with the mass m it holds [8]

$$r_{ef(g)} = \left(R_{g(m)}.a\right)^{1/2} \qquad (9)$$

where $R_{g(m)}$ is the gravitational diameter of the particle. It can be subsequently shown that the absolute value of the gravitational energy of a virtual black hole with the radius $r_{ef(g)}$ is equal exactly to the rest energy of the particle, i.e. to $m.c^2$.

Conclusions

The present contribution is a tentative proposal of a new direction that might lead to unification of the fundamental physical interactions. As a starting

point, the ENU model exploiting the Vaidya metrics and enabling to localize gravitational energy is used. The paper provides conclusions on relation between strong interactions and gravitation as the first approximation to the elaborated issue, the next steps are expected to involve time-dependent modified Vaidya, Reissner-Nordstrm and Kerr-Newman metrics.

References

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